Water Shortage Problems and Strategies for Water Sustainable Utilization in China

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Water is the most essential condition for the sustainable development of human society. It is one of the shortest resources for China in the 21 century. During the new century, while people utilizing and mobilizing water resources to support the social and economic developments, an increasingly important core problem that must be considered carefully not only for the present time, but also for the future too is to ensure the positive development of ecosystem. Therefore, the new mode of water management must be an ecosystem protection oriented management system. This is a system, where the protection and proper development of ecosystem, protection of other environmental elements, water resource utilization and protection, social and economic developments are well reconciled.

1. Views about the term of sustainable utilization of water resource

There are many definitions and discussions about the contents of the sustainable utilization of water resource. However the understanding of the major point is widely accepted, and the essence is as the following. The human being water utilization activities, while trying to satisfy the requirements for their living, improving life level, and other development requirements, should as much as possible eliminate any environmental worsening caused by human activities, and be beneficial to ecosystem protection. The understanding of sustainable utilization of water resource can be different in different areas (geographical and climate condition differences), in different time periods (changes in water demands and supplying ability), and even for different cultural background. However, the general tendency is that people are continuously developing this new concept of sustainable utilization of water resource, and are promoting people's water use activities to a stage of being well reconciled together with environmental and ecosystem protections.

2. Water shortage problem

According to the water barrier demarcations of Falkenmark et al (table 1)[1], the general water resource situation for the continent of China is not optimistic (table2) [2]. By the 20-30's of the 21st century, it is predicted that the population of China will grow to 1.6 billion, and the water resource per person at that time will be about 1717 m^3, close to the "stress condition". In addition to that, recent research shows that for latest 40 years, the precipitation for the whole continent of China has a tendency to decrease by 12.7 mm every 10 years[3]. According to use-to-resource ratio concept,

although there is no unanimously accepted values to link the ratio to the levels of water sufficiency, however, for purposes of analysis, there are still some suggestions of certain ratio value considered as indicative of water stress. Namely: 20% (Balcerski), 33% (Gleick), and 25% (P.D. Raskin). Using these indicatives, and at the same time noticing the prediction that the total water demand will increase at a rate of about 1.5 % yearly, which will be about 800 km^3 and the use-to-resource ratio in China will be above 28% by 2050 [3], indicating that the whole country will enter into the range of countries where its water resource is under stress.

Table 1 Water barrier demarcations

Index (m^3 per capita)	Condition
>1700	No stress
1000-1700	Stress
500-1000	Scarcity
<500	Absolute scarcity

Source: Falkenmark and Widstrand[1] (1992).

Viewing the problem from some other points, one can notice that the North China Region has the water resource per capita of about 556 m^3, which is 1/20 of that of the world. The Haihe and Huaihe River Basin Area has the water resource per capita of 300-500 m^3, and even less for the municipalities along those two rivers. The Northwest China Area is the most arid and ecologically vulnerable area in China. For most regions in that area, annual precipitation is less than 400 mm, in some places it ranges only some tens of millimeters, for example, in the middle of the Tarim Basin, it is only 24.4 mm. However the water resource per person is higher than that of the whole country. Among them[•], the North Xinjiang has the water resource per person in some places as low as 3449 m^3, and in some places it can reach 18870 m^3. In the South Xinjiang, the water resource per person ranges from the lowest value of 6048 m^3 to the highest of 10923 m^3. In the Hexi Corridor Area the water resource per person is 1590 m^3, if calculating for its river basins, then for Shiyang Rivers - 906 m^3, Heihe Rivers - 1809 m^3, Shule Rivers - 4671 m^3. However, all the Northwest Area is suffering from severe shortage of water resources.

Obviously, how to evaluate the water resource situation is still a problem that needs to be developed in the future. Firstly, the Northwest Area has the resource per person higher than that of the country, in some places it can be higher than 10000 m^3, notwithstanding it is a water shortage area. The reason for that is due to the little population in the whole area, as well as to the uneven distribution of water resource and population within the area too. The use-to-resource ratio has its own problem either. For example, at present the indicator for China as a country in whole is 16.7%, however the averaging effect of low ratio in the Southwest Area (3.6%) masks the nature of problem. In fact among 5 economic areas there are three areas where the ratio is higher than 20% (North China-

• Zhang Zonghu, Problems of water resources in the Northwest of China, Report 1996, Institute of Hydrogeology and Engineering Geology, Chinese Academy of Geological Sciences, 1996, pp.2-4.

62.4%; Southeast Area-21.9%; Northwest Area-34.9%). Therefore, the water resource situation for the whole country is not optimistic, and for the North China and Northwest Area, it is already under water stress.

Table 2 Water sufficiency situation for the whole Country of China and its 5 regions

	Total Resource (km^{3l})	Resource per person (m^3 per capita)	Resource per cultivated land (1000 m^3/ha)	Total withdrawal (km^3)			Use/resource (%)
				Total	Agricul-ture	Municipa-lity and industry	
Whole country	2746	2408.8	28.7	459.8	438.9	20.9	16.7
Northeast Region	152.9	1530	9.42	28.1	24.8	3.3	18.4
North China	168.5	555.6	5.65	105.1	99.9	5.2	62.4
Northwest Region	223.5	2787.6	19.49	77.9	76.5	1.4	34.9
Southwest Region	1275.2	5721.9	92.29	45.6	43.9	1.7	3.6
Southeast Region	925.9	2134.9	38.1	203	193.8	9.2	21.9

Source: FEI Jin[(2)], 1996.

3. Some suggestions

- Strengthening the study on the water resource formation, evolution procedures from the viewpoint of systems analysis and dynamic analysis in order to reveal the exploitable capacity or the loading capacity of the water resource system, so that the scientifically sound predictions and related technologies can be derived out.

- In order to enhance our ability to predict the changes of water resource for 10-30 years in the future, it is necessary to strengthen the study on water resource formation and environmental change in different space and temporal scales, including the cycling, recharging, and non-recharging procedures and their time delay effects in the geological history.

- A new comprehensive science research system which links different spheres of the earth surface system, is necessarily to be established, and this should be an essential way to solve the water problem, scientific utilization of water resource, environmental protection, as well as to ensure the sustainable development of the country's economy. For solving the water problems, it is necessary to break out many man-made, either ideal, or practical limitations and fences between different departments, organizations, and different disciplines. Only if a multidiscipline joint research on water and environment can be carried out, the sophisticated problem can be understood better and the practical problems can be solved finally.

- To realize the importance of, and to promote the development of a highly water saving strategies, as well as a highly efficient water-use strategies. To establish a unified water management system, including the establishment of a unified institutional system, strengthening and completing the legislation constructions, as well as the establishment of the market system of an effective water resource. Only in this way, a highly water saving economy and society can be established step by step.

- The water resource shortage, water pollution, and the frequent occurrence of drought and flood disasters should be dealt comprehensively.

- In order to solve water problems, it is necessary to study the water cycling system at a level of regional or continental scale to comprehensively research the reasons, mechanism, and countermeasures for the problem.

- The following understanding must be established [4].

1. The human activity interference in water and ecological environments must be limited within the range of the loading capability of the natural system.
2. The consumption rate of water resource must be kept within the rate of its renewability.
3. The fee for and the income from utilization and protection of water resource and environmental resource should be balanced by the market system.
4. Encouraging the development of water resource saving and environmental protection technologies.
5. Encouraging the cultural consciousness to respect the nature, to protect the environment, and to be responsible for our further generations.

- To realize zero increase in the demand for fresh water resource, and to encourage its negative increase should be a target for China in 30-50 years from now on.

- The problems such as evaluation of regional groundwater resource loading ability, its protection and scientific utilization are the highly important problems. Especially in the Northwest Arid Area, where the changes in climate and surface water flow are very significant, therefore protection and rational utilization of groundwater resource becomes increasingly important for the future social development.

References

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